DOE/RL-2001-48
Rev. 4

300 Area Remedial Action Sampling and Analysis Plan

United States
Department of Energy

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DOE-RL AND/OR REGULATOR APPROVAL PAGE

Title: 300 Area Remedial Action Sampling and Analysis Plan

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Signature Date 11/12/14

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Signature Date 11/14/14

DOE/RL-2001-48
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300 Area Remedial Action Sampling and Analysis Plan

November 2014

United States Department of Energy

P.O. Box 550, Richland, Washington 99352

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ACRONYMS

CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
COC	contaminant of concern
CRATER™	Compton Ratio Analysis Testing for Environmental Radioactivity
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy, Richland Operations Office
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
FSP	field sampling plan
HASQARD	*Hanford Analytical Services Quality Assurance Requirements Documents*
HEIS	Hanford Environmental Information System
NDA	nondestructive assay
OU	operable unit
OVA	organic vapor analyzer
QA	quality assurance
QC	quality control
QAPjP	quality assurance project plan
RDR/RAWP	remedial design report/remedial action work plan
ROD	Record of Decision
RPD	relative percent difference
RTD	remove, treat as necessary, dispose
S&C	sampling and characterization
SAP	sampling and analysis plan
SFL	standard fixed laboratory
SOP	standard operating procedure
TRU	transuranic
VPU	vertical pipe unit
VSP	Visual Sample Plan
WAC	*Washington Administrative Code*
WCH	Washington Closure Hanford
WFM	waste form model
XRF	x-ray fluorescence

METRIC CONVERSION CHART

Into Metric Units			Out of Metric Units		
If You Know	*Multiply By*	*To Get*	*If You Know*	*Multiply By*	*To Get*
Length			**Length**		
inches	25.4	millimeters	millimeters	0.039	inches
inches	2.54	centimeters	centimeters	0.394	inches
feet	0.305	meters	meters	3.281	feet
yards	0.914	meters	meters	1.094	yards
miles	1.609	kilometers	kilometers	0.621	miles
Area			**Area**		
sq. inches	6.452	sq. centimeters	sq. centimeters	0.155	sq. inches
sq. feet	0.093	sq. meters	sq. meters	10.76	sq. feet
sq. yards	0.836	sq. meters	sq. meters	1.196	sq. yards
sq. miles	2.6	sq. kilometers	sq. kilometers	0.4	sq. miles
acres	0.405	hectares	hectares	2.47	acres
Mass (weight)			**Mass (weight)**		
ounces	28.35	grams	grams	0.035	ounces
pounds	0.454	kilograms	kilograms	2.205	pounds
ton	0.907	metric ton	metric ton	1.102	ton
Volume			**Volume**		
teaspoons	5	milliliters	milliliters	0.033	fluid ounces
tablespoons	15	milliliters	liters	2.1	pints
fluid ounces	30	milliliters	liters	1.057	quarts
cups	0.24	liters	liters	0.264	gallons
pints	0.47	liters	cubic meters	35.315	cubic feet
quarts	0.95	liters	cubic meters	1.308	cubic yards
gallons	3.8	liters			
cubic feet	0.028	cubic meters			
cubic yards	0.765	cubic meters			
Temperature			**Temperature**		
Fahrenheit	subtract 32, then multiply by 5/9	Celsius	Celsius	multiply by 9/5, then add 32	Fahrenheit
Radioactivity			**Radioactivity**		
picocuries	37	millibecquerel	millibecquerels	0.027	picocuries

1.0 INTRODUCTION

This sampling and analysis plan (SAP) presents the rationale and strategy for sampling and analysis activities to support soil remedial actions at waste sites in the 300-FF-2 Operable Unit (OU), including the 618-10 Burial Ground and 618-11 Burial Ground. Previous revisions of this SAP have been used to support interim remedial actions at 300-FF-2 waste sites and final remedial actions at 300-FF-1 waste sites. This revision provides consideration for the final action decision for 300-FF-2 waste sites provided in the *Record of Decision for 300-FF-2 and 300-FF-5, and Record of Decision Amendment for 300-FF-1* (hereafter referred to as the 300 Area ROD) (EPA 2013). Remediation work at 300-FF-2 waste sites will be implemented through DOE/RL-2014-13, *Integrated Remedial Design/Remedial Action Work Plan for the 300 Area (300-FF-1, 300-FF-2, & 300-FF-5 Operable Units)* (300 Area Integrated RDR/RAWP) and DOE/RL-2014-13-ADD1, *Remedial Design Report/Remedial Action Work Plan for 300-FF-2 Soils* (RDR/RAWP Soil Addendum).

1.1 BACKGROUND

The Hanford Site is a 1,517-km^2 (586-mi^2) federal facility located along the Columbia River in southeastern Washington State. From 1943 until 1990, the primary mission of the Hanford Site was to produce nuclear materials for the nation's defense mission. In July 1989, the Hanford Site was listed on the National Priorities List under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA), as amended by the *Superfund Amendments and Reauthorization Act of 1986*. The Hanford Site was divided up and listed as four National Priorities List sites consisting of the 100 Area, the 200 Areas, the 300 Area, and the 1100 Area. The 300 Area is adjacent to the Columbia River and approximately 1.6 km (1 mi) north of the Richland city limits. The 300 Area began operations in 1943 as a fuels fabrication complex for the nuclear reactors located in the 100 Area. Most of the facilities in the 300 Area were involved in the fabrication of nuclear reactor fuel elements. In addition to the fuel manufacturing processes, technical support, service support, and research and development related to fuels fabrication also occurred within the 300 Area. In the early 1950s, the Hanford Laboratories were constructed for research and development. As the Hanford Site production reactors were shut down, fuel fabrication in the 300 Area ceased. Research and development activities have expanded over the years. The 300 Area contains a number of support facilities with ongoing missions and other facilities necessary for research and development that will remain in the 300 Area for some time.

Operations in the 300 Area created both liquid and solid wastes. Prior to 1994, liquid wastes were discharged to a series of unlined ponds and process trenches north of the 300 Area. Solid waste and debris generated by 300 Area operations were disposed of in several unlined burial grounds and dump sites until 1973. These burial grounds were located north and west of the 300 Area complex. After 1973, waste from the 300 Area was disposed in burial grounds in the 200 Area.

The 300 Area was divided into OUs, which are groupings of individual sites based primarily on geographic area and common waste sources. The 300 Area consists of three OUs (Figure 1-1), encompassing the 300 Area industrial complex area (Figure 1-2) and surrounding areas. The 300-FF-1 and the 300-FF-2 OUs address contamination at burial grounds and other soil waste sites. The 300-FF-5 OU addresses groundwater contamination associated with these waste sites. Much of the 300 Area site has been or is in the process of being cleaned up in accordance with prior CERCLA RODs and Action Memoranda as described in the 300 Area Integrated RDR/RAWP (DOE/RL-2014-13). Contaminated buildings are being removed in accordance with CERCLA Action Memoranda and are not part of the OUs addressed by the 300 Area ROD (EPA 2013).

The 400 Area contains 300-FF-2 waste sites with relatively little contamination associated with the Fast Flux Test Facility. The Fast Flux Test Facility reactor, which is not part of the 300-FF-2 OU, operated from 1980 until 1992. It is located approximately 8 km (5 mi) northwest of the 300 Area industrial complex and about 6 km (4 mi) west of the Columbia River.

1.1.1 300-FF-1 Operable Unit

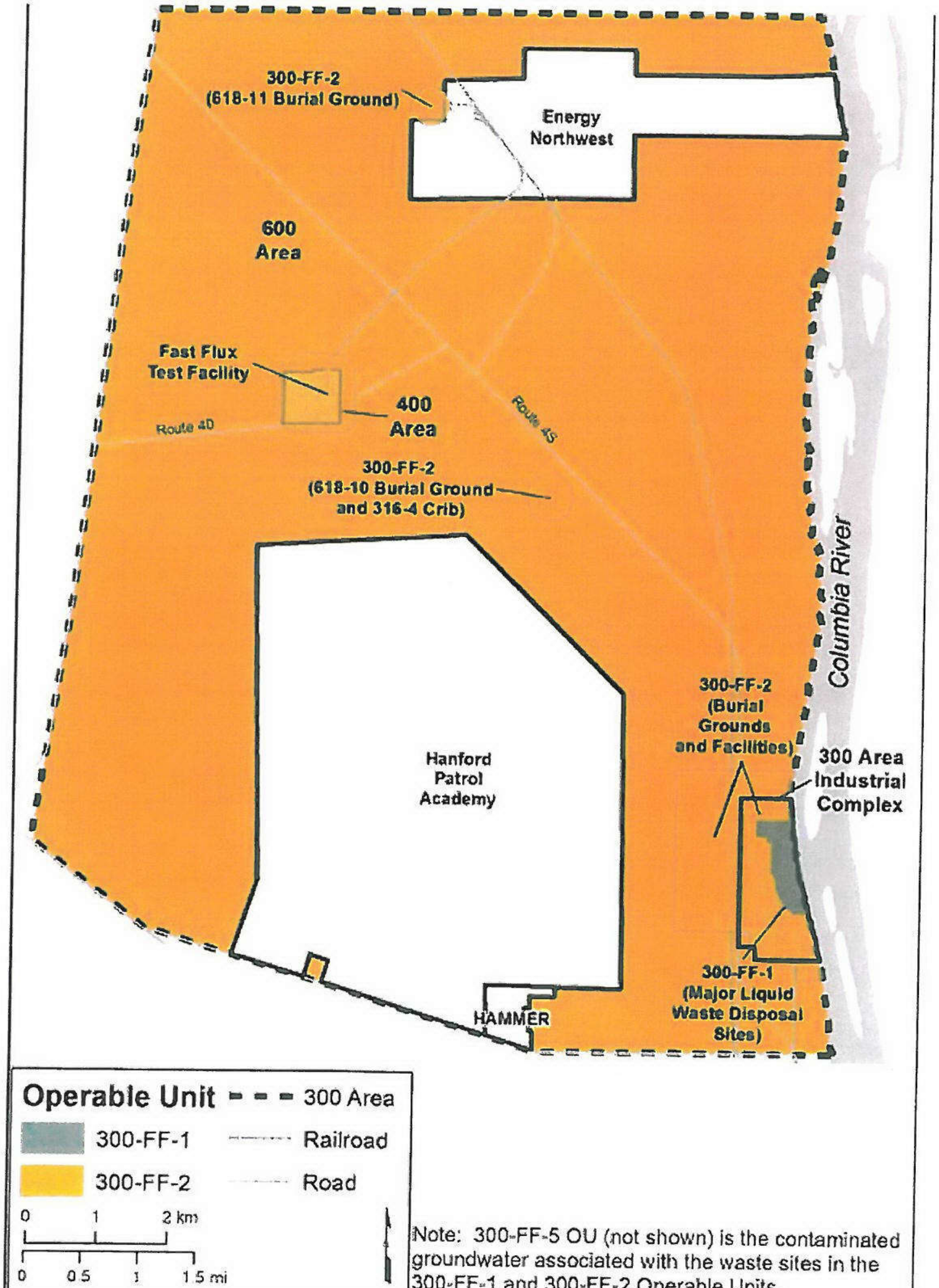
The 300-FF-1 OU covers an area of approximately 47.4 ha (117 ac) that contained many of the past 300 Area liquid waste disposal units, the 618-4 Burial Ground, and three small landfills. The 300-FF-1 liquid/process waste sites were unlined trenches and ponds that routinely received discharges of millions of gallons of contaminated wastewater from 300 Area operations between 1943 and 1994. These liquid/process waste sites were suspected to be the primary source of groundwater contamination addressed in the scope of the 300-FF-5 OU. ,.

Remedial actions and associated sampling activities for the 300-FF-1 OU were initiated in 1997 in accordance with the *Record of Decision for the 300-FF-1 and 300-FF-5 Operable Units, Hanford Site, Benton County, Washington* (300-FF-1/300-FF-5 ROD) (EPA 1996) and DOE/RL-96-70, *300-FF-1 Remedial Design Report/Remedial Action Work Plan* (300-FF-1 RDR/RAWP). The selected remedy for the 300-FF-1 OU specified remediation of the waste sites based on an industrial land-use scenario. Excavation operations and the verification sampling process have been completed for all of the 300-FF-1 OU waste sites.

1.1.2 300-FF-2 Operable Unit

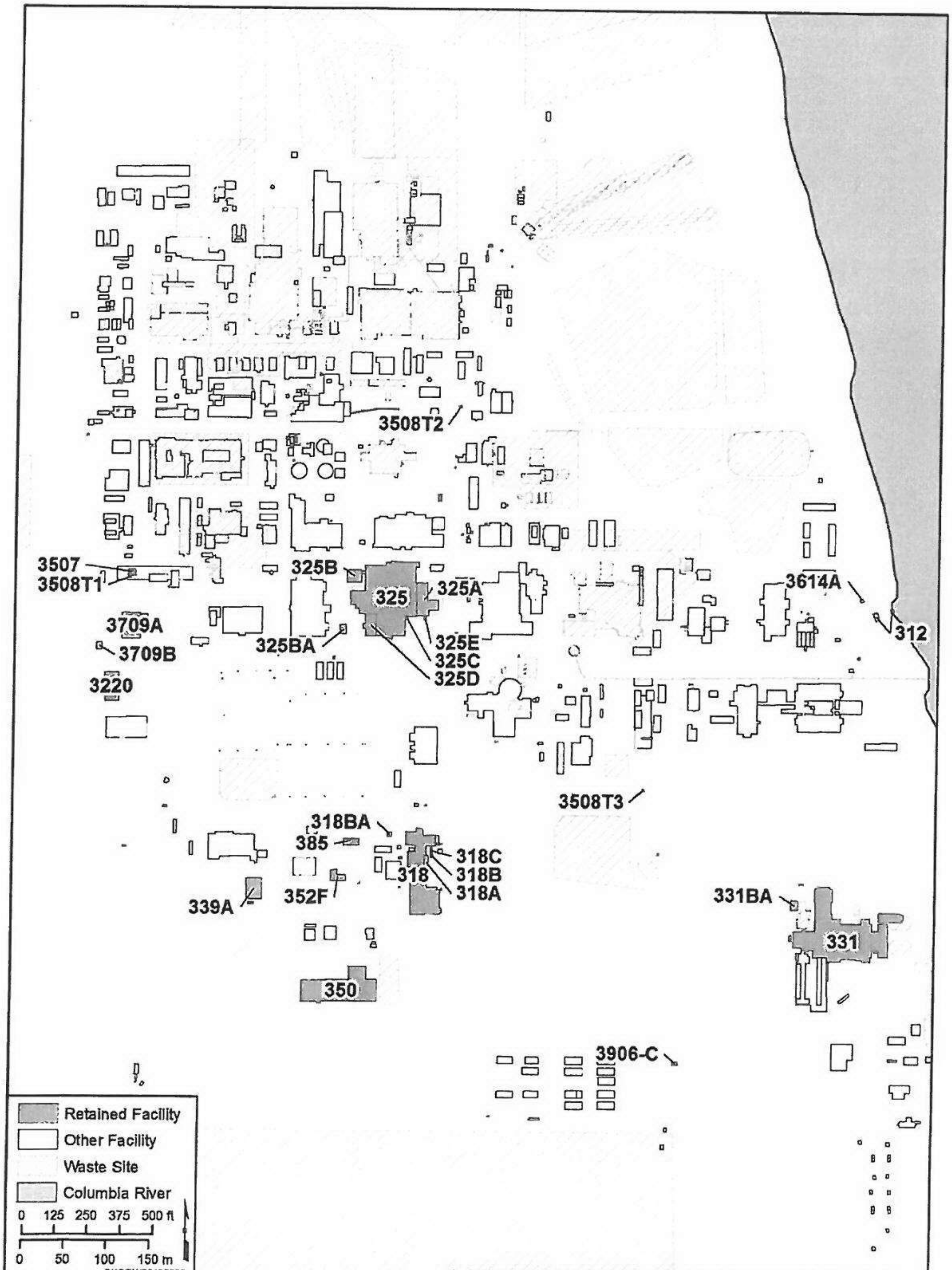
The 300-FF-2 OU is composed of waste sites that fall into four general categories: waste sites in the 300 Area industrial complex, outlying waste sites north and west of the 300 Area industrial complex, general content burial grounds, and transuranic- (TRU-) contaminated burial grounds, including the 618-10 and 618-11 Burial Grounds. The selected remedy for the 300-FF-2 OU is described in the 300 Area Integrated RDR/RAWP (DOE/RL-2014-13).

Figure 1-1. 300 Area Operable Units.



Note: 300-FF-5 OU (not shown) is the contaminated groundwater associated with the waste sites in the 300-FF-1 and 300-FF-2 Operable Units.

Figure 1-2. 300 Area Industrial Complex Waste Sites and Facilities.



The 618-10 and 618-11 Burial Grounds are located northwest of the core industrial portion of the 300 Area. During the years that these burial grounds were active, they received low- to high-activity radioactive waste from the 300 Area laboratories and fuels development facilities. The low-activity wastes were primarily disposed in trenches, while the moderate- and high-activity wastes were disposed in vertical pipe units (VPUs) (typically constructed of five 208-L [55-gal] bottomless metal drums welded together) or caissons. Some of the moderate- to high-activity wastes were also disposed to trenches in concrete and concrete/lead-shielded drums. The potential for TRU wastes is expected at both the 618-10 and 618-11 Burial Grounds. Remediation of the 618-10 Burial Ground is currently ongoing.

1.2 SAMPLING AND ANALYSIS PLAN SCOPE AND OVERVIEW

The scope of this SAP includes the waste sites identified for remediation by remove, treat, and dispose (RTD) in the 300 Area ROD (EPA 2013). These waste sites include a combination of burial grounds, pipelines, and other waste sites. The scope of the proposed sampling and analysis activities at these sites is two-fold:

- Characterization of co-mingled soil, buried waste, and debris excavated from the sites to support remediation waste characterization and disposal
- Demonstration that post-remediation cleanup objectives have been met for residual soil in pits/trenches, stockpiled soil intended for use as clean backfill material, and residual soil at staging pile areas to support site closeout.

The scope of this SAP does not include characterization of the VPUs or caissons at the 618-10 and 618-11 Burial Grounds, which will be addressed by a separate SAP. Demonstration that post-remediation objectives have been met for the post-remediation footprint of the VPUs and caissons will be performed in accordance with this SAP. Waste characterization activities at the 618-10 and 618-11 Burial Grounds may also utilize other stand-alone documents separate from this SAP, similar to the SAPs developed for the nonintrusive characterization of the 618-10 and 618-11 Burial Grounds (trenches and VPUs) (DOE/RL-2008-27, *Sampling and Analysis Plan for 618-10 and 618-11 Nonintrusive Sampling*) and intrusive characterization of 618-10 Burial Ground trenches (DOE/RL-2009-64, *Sampling and Analysis Plan for Intrusive Characterization of 618-10 Burial Ground Trenches*). The scope of this SAP also does not include groundwater or considerations associated with the enhanced attenuation remedy component of the ROD.

This SAP supports the development of lower tier documents such as the following:

- Verification work instructions, which are used to present waste site-specific sampling approaches and methods that will support site closure
- Site-specific waste management instructions, which provide guidance for remediation waste management

- Data quality assessments, which are integrated with cleanup verification packages to support use of analytical data for waste site closure or other reclassification
- Third-party data validation packages, which are integrated into the overall data quality assessment process.

1.2.1 Data Quality Objectives

In 2001, the *Guidance for Data Quality Objectives Process* (EPA 1994) was used to support the development of the sampling and analytical requirements for remediation and closeout of the 300-FF-2 OU waste sites (BHI-01501). This data quality objectives (DQO) process provided a strategic planning approach that used a systematic method of defining the criteria that a data collection design should satisfy. Using the DQO process ensured that the type, quantity, and quality of environmental data used in decision-making was appropriate for the intended application. The U.S. Environmental Protection Agency's (EPA's) *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA 2006) was also used to support revision of this SAP.

The 618-10 and 618-11 Burial Grounds were excluded from the DQO summary report (BHI-01501) due to the burial ground containing TRU waste, primarily in VPUs. However, the 618-10 Burial Ground trenches are similar to other 300 Area burial grounds in the respect that they contain buried heterogeneous solid materials, both known and anomalous. For this reason, the existing DQO process (BHI-01501) was adopted for the 618-10 Burial Ground trenches along with DQO processes developed for the nonintrusive characterization and intrusive characterization phases. The DQO process for the intrusive characterization of the 618-10 Burial Ground trenches was documented in WCH-359, *Data Quality Objectives Summary Report for the Intrusive Characterization of 618-10 Burial Ground Trenches*. The DQO process for intrusive characterization of the VPUs will be addressed as part of a separate SAP development.

A summary of essential information based on the DQO summary report (BHI-01501) and EPA (2006) that is pertinent to this SAP is provided in the following subsections.

1.2.1.1 Statement of the Problem. The waste sites will be remediated in accordance with the RTD selected remedy component prescribed by the 300 Area ROD (EPA 2013). The following problem statements were developed for the scope of these remedial actions.

- **Waste characterization:** The problem is to determine if buried solid wastes and co-mingled soils in the 300-FF-2 waste sites are a dangerous, radioactive, and/or mixed waste for proper waste disposition.
- **Site closeout:** The problem is to determine if the 300 Area waste sites are suitable for closeout after remediation. A second part of the problem is to determine if overburden material from the waste sites is suitable for use as backfill.

1.2.1.2 Decision Rules. Based on the inputs from steps 2 through 4 of the DQO process, this section captures the decision rule outputs from step 5 of the DQO process (BHI-01501, EPA 2006). The decision rules for waste characterization and site closeout are provided in Tables 1-1 and 1-2, respectively.

Table 1-1. Waste Designation Decision Rules.

#	Decision Rule
1	If the true population (as estimated by the maximum or average survey results, <u>OR</u> the average or single sample results)[a] activity of radionuclides within the pockets of unique solid waste or co-mingled soil samples is greater than or equal to the disposal facility waste acceptance criteria limits, negotiate disposition with regulators; otherwise, dispose solid waste/soil in an approved disposal facility.
2	If the true population (as estimated by process knowledge, the 80% UCL, or maximum detected sample values) [a] concentrations of chemical constituents within the pockets of unique solid waste or co-mingled soil samples exceed the dangerous, asbestos, or PCB waste limits, then designate as dangerous, asbestos, or PCB waste; otherwise, disposition wastes without waste codes.
3	If the true population (as estimated by any detected sample values) concentrations of land disposal restricted materials or underlying hazardous constituents in the treated waste are equal to or greater than the universal treatment standards and disposal facility waste acceptance criteria, provide additional treatment prior to disposal; otherwise, dispose solid waste/soil without additional treatment.

[a] As determined by the waste designation specialist and the project engineer. The maximum sample value will be used for PCB designation. Field observations and/or measured fiber counts will be used for asbestos designation.

PCB = polychlorinated biphenyl
UCL = upper confidence limit

Table 1-2. Site Closeout Decision Rules.

#	Decision Rule
1	If the 95% UCL value or maximum of the activity of radionuclides in the shallow zone or overburden selected per Section B.4.6 of Appendix B of DOE/RL-2014-13-ADD1, *Remedial Design Report/Remedial Action Work Plan for 300-FF-2 Soils*, results in a radiological exposure dose greater than or equal to the carcinogenic risk limit of $1x10^{-4}$ based on RESRAD modeling, remove the radiologically contaminated soils; otherwise, initiate waste site closeout.
2	If the 95% UCL value or maximum of the activity of radionuclides in the shallow zone, deep zone, or overburden selected per Section B.4.6 of Appendix B of DOE/RL-2014-13-ADD1, *Remedial Design Report/Remedial Action Work Plan for 300-FF-2 Soils*, are predicted to result in groundwater/river impacts based on exceedance of CULs (and potential consideration of site-specific modeling), remove the radiologically contaminated soils; otherwise, initiate waste site closeout.
3	If the 95% UCL value or maximum of the concentrations of chemical constituents in the shallow zone, deep zone, or overburden selected per Section B.4.6 of Appendix B of DOE/RL-2014-13-ADD1, *Remedial Design Report/Remedial Action Work Plan for 300-FF-2 Soils*, are equal to or greater than the appropriate cleanup levels or greater than carcinogenic or noncarcinogenic risk limits (including potential consideration of site-specific modeling), remove the chemically contaminated soils; otherwise, initiate waste site closeout.

CUL = cleanup level
RESRAD = RESidual RADioactivity (dose model) (ANL 2009)
UCL = upper confidence limit

1.2.1.3 Error Tolerance and Decision Consequences. Error tolerance and decision consequences are specified for statistical sampling designs in step 6 of the DQO process (BHI-01501, EPA 2006). Based on information developed in the DQO processes, a judgmental (nonstatistical) sampling design was specified for waste characterization. Consequently, error tolerances and decision consequences are not defined for waste characterization purposes.

A combination of judgmental (biased/focused) and/or statistical sampling designs is specified for site closeout. This section summarizes the selection of decision error tolerances needed to support the statistical designs for site closeout and the data assessment performed after the SAP has been implemented. Several inputs for determining the acceptable rates of decision error are required, which include defining the types of decision errors and the statement of a null hypothesis for each decision, specifying the acceptable rates of decision error, and determining the upper and lower bounds of the gray region.

Two types of decision errors that could occur include (1) treating clean material as if it were contaminated, and (2) treating contaminated material as if it were clean. For site closeout sampling, the decision error that has a more severe consequence is the latter since the error could result in negative consequences for human health and the environment.

The term "null hypothesis" refers to the baseline condition of the site, which has been defined based on historical data and process knowledge. The null hypothesis states the opposite of what is hoped to be demonstrated. The two possible null hypotheses and the associated selection for site closeout are presented in Table 1-3.

Tolerable decision error rates for site closeout are summarized in Table 1-4. The 95% upper confidence limits specified correspond to a 5% tolerable error rate for mistakenly concluding that the action level is not exceeded. This error tolerance is applied to many of the decisions.

Table 1-3. Statement of the Null Hypothesis for Site Closeout.

Null Hypothesis Statement	Indicate Selection
Site media is assumed to be contaminated until it is shown to be clean.	X
Site media is assumed to be clean until it is shown to be contaminated.	

Table 1-4. Tolerable Decision Errors for Site Closeout.

Media	COCs	Statistical Parameter of Interest	Range of Statistical Parameter of Interest	Cleanup Level	LBGR	Tolerable Decision Error Rates	
						At LBGR (%)	At Cleanup Level (%)
Soil	Radiological and chemical COCs	True population mean	Near background, to action level	See Table 2-1	50% of action level	20% or less [a,b]	5% [c]

[a] Error rate associated with deciding a site is dirty when the true mean is at the LBGR.
[b] The upper bound of the gray region is the selected cleanup level value. The LBGR is a target value that may be exceeded in practice.
[c] Error rate associated with deciding a dirty site is clean when the true mean is equal to the cleanup level.
COC = contaminant of concern
LBGR = lower bound of gray region

1.2.1.4 Sample Design Summary. As stated previously, the objectives of the sampling and analytical strategies documented in this SAP are to support waste characterization and to verify that residual soil meets the cleanup levels. A judgmental sampling design was selected for waste characterization. As a supplement to available process knowledge and/or historical records, the waste characterization sampling design approach was developed to fill in data gaps. The amount of sampling required varies based on the type of waste unearthed. Details for the waste characterization sample design are provided in Section 3.0.

Originally, a random sampling within blocks design was selected to support site closeout for the 300 Area waste sites (BHI-01501). Blocks were used as subdivisions within the decision units of the waste site in which discrete samples were collected. The number of blocks was based on the aerial footprint of the excavated site. This type of sampling design considered the excavated waste site as one population with subdivided units and used composite sampling within each block. However, in the past 10 years, with the addition of candidate waste sites to the 300-FF-2 ROD (EPA 2001b) and the development and availability of Visual Sample Plan (VSP)[1], site-specific statistical sampling designs that use a random start systematic sampling grid have been demonstrated to be defensible and appropriate for waste site closeout.

After a waste site is remediated, a post-excavation civil survey or global positioning survey is used to determine the boundaries of the excavation area, overburden/layback soil stockpiles, and waste staging pile area footprints requiring verification soil sampling. Information obtained during remediation, including waste characterization and in-process sample results, is used to stratify the waste site excavation, soil stockpiles, and waste staging areas into decision units for verification sampling. In some cases, multiple waste sites are located in the same area and are remediated together. In such cases, the waste sites may be grouped together for cleanup verification sampling. Sampling designs are developed for each decision unit, typically using a random-start, triangular grid or sampled using a focused/judgmental approach, or a combination

[1] Visual Sample Plan is a site map-based user-interface program that may be downloaded at http://vsp.pnnl.gov/.

of both. For statistical sample designs, a minimum of 12 statistical soil samples are collected for each sampling decision unit. Appropriate statistical parameters developed in the DQO process are used in VSP to prepare the sampling design. Focused samples are selected at locations that exhibit visual soil stains, liquid wastes were buried, waste characterization sampling indicates contaminant concentrations exceed remedial action goals, large inventories of hazardous waste were buried, or process knowledge indicates the potential for elevated concentrations of alpha or beta contamination. The sample design and applicable analytical methods are specified in a site-specific work instruction for approval by EPA and the U.S. Department of Energy (DOE). Sampling design features are summarized in Table 1-5.

Table 1-5. Features of the Sampling Design for Site Closeout.

Sampling Design:
Excavation Guidance
• For radiologically contaminated sites, radiological surveys are performed after excavation and removal of buried solid waste and co-mingled soils. Excavation and surveys will continue until the radiological cleanup levels have been met as indicated by the field radiological survey results.
• After excavation and removal of buried solid waste and co-mingled soils, in-process residual soil samples may be collected beneath specific locations within the burial grounds that had visual stains, contained buried liquid wastes, where waste characterization sampling indicated chemical concentrations above the selected cleanup levels, and in areas with large inventories of dangerous/hazardous wastes (e.g., lead bricks). [a]
• After removal of buried waste and co-mingled soils, in-process samples of the residual soil may be collected at specific locations where process knowledge indicates the potential for elevated contamination.
Verification Sampling
• Collect verification samples from the excavated waste site(s). For statistical sampling designs, stratify the excavation into decision units as appropriate and collect a minimum of 12 discrete statistical soil samples from each decision unit for laboratory analysis. Nonstatistical verification sampling designs with an appropriate number of focused samples may be approved in site-specific sampling instructions. For statistical samples, analyze samples for all site closeout final COCs for the specific waste site.
• Collect verification samples from the overburden stockpiles, if applicable. For statistical sampling designs, collect a minimum of 12 discrete statistical soil samples for laboratory analysis. Nonstatistical sampling designs may be approved in site-specific sampling instructions. Analyze samples for all site closeout final COCs for the specific waste site.
• Collection of verification samples from staging pile area footprints. For statistical sampling designs, collect a minimum of 12 discrete statistical soil samples for laboratory analysis. Nonstatistical sampling designs may be approved in site-specific sampling instructions. Analyze samples for all site closeout final COCs for the specific waste site.
• Focused verification samples from the excavation, overburden stockpiles, and beneath staging pile areas will be collected as appropriate. Collect focused samples at selected locations with the potential for higher residual contamination (e.g., based on visual soil stains, where liquid wastes were buried, where waste characterization sampling indicates chemical constituent concentrations exceed cleanup levels, where large inventories of hazardous waste identified, or where process knowledge indicates the potential for elevated concentrations of alpha or beta contamination).

[a] Residual soils with visual stains and detected concentrations of chemical COCs and non-COCs above the cleanup levels will be excavated and resampled until the cleanup levels have been met.

COC = contaminant of concern

1.3 CONTAMINANTS OF CONCERN

The contaminants of potential concern were initially identified by evaluating the history of operations in the 300 Area and analysis of soil and groundwater samples over time. The initial contaminants of potential concern were refined to contaminants of concern (COCs) during development of the 300 Area ROD (EPA 2013) and include radionuclides, metals, asbestos, inorganic anions, semivolatile organics, and polychlorinated biphenyls (Table 1-6).

Table 1-6. Contaminants of Concern Identified for 300-FF-2 Waste Sites.

Radionuclides	Metals	Volatile Organics
Americium-241	Antimony	1,1,1-Trichloroethane
Cesium-137	Arsenic	1,2-Dichloroethene (total)
Cobalt-60	Barium	Methyl ethyl ketone (2-Butanone)
Europium-152	Beryllium	Methyl isobutyl ketone (hexone) (4-Methyl-2-pentanone)
Europium-154	Cadmium	Benzene
Europium-155	Chromium (total)	Carbon tetrachloride
Iodine-129	Chromium (hexavalent)	Chloroform
Plutonium-238	Cobalt	Cis-1,2-Dichloroethene (DCE)
Plutonium-239/240	Copper	Ethyl acetate
Plutonium-241	Lead	Ethylene glycol
Strontium-90	Lithium	Hexachlorobutadiene
Technetium-99	Manganese	Hexachloroethane
Tritium	Mercury	Tetrachloroethene
Uranium-233/234	Nickel	Toluene
Uranium-235	Selenium	Trichloroethene
Uranium-238	Silver	Vinyl chloride
Nonvolatile Organics	Strontium	Xylene
Total petroleum hydrocarbons		**Semivolatile Organics**
Normal paraffin hydrocarbon (kerosene)	Tin	Benzo(a)pyrene
PCB Aroclor 1016	Uranium (total)	Chrysene
PCB Aroclor 1221	Vanadium	Phenanthrene
PCB Aroclor 1232	Zinc	Tributyl phosphate
PCB Aroclor 1242	**Other**	**Inorganic Anions**
PCB Aroclor 1248	Asbestos	Cyanide
PCB Aroclor 1254		Fluoride
PCB Aroclor 1260		Nitrate

PCB = polychlorinated biphenyl

It is possible that additional contaminants may be identified as part of waste characterization during waste site remediation. Should this occur, these constituents will be discussed with the U.S. Department of Energy, Richland Operations Office (DOE-RL) and EPA and potentially be considered in site closeout sampling and analysis. A final list of COCs for site closeout will be identified by the project with concurrence from the DOE and EPA as part of initiating the verification sampling process. Final COCs will be presented in site-specific cleanup verification packages.

The DQO scoping investigations (i.e., process knowledge and data from burial ground remediation activities) within the 300-FF-2 OU revealed that repetitive waste forms are expected in the 300 Area waste sites. Consequently, waste form models (WFMs) were developed for each class or type of buried waste to support waste characterization and designation. These WFMs are linked with potential contaminant group lists as shown in Table 1-7. These lists identify potential contaminants that may need to be considered to support waste characterization, treatment, and disposal.

The waste designation process considers all available information and is not limited to results from sampling for the contaminants identified in Table 1-7. If reported analytical results, process knowledge, or historical data identify concentrations of other potential contaminants, these contaminants will be considered in the waste profiles developed for the site being evaluated.

Table 1-7. Waste Form Models and Potential Contaminants. (2 Pages)

Waste Form No.	Waste Form Model	Known or Suspected Source of Contamination	Type of Contamination (General)	Potential Contaminants (Specific)
1	Demolition debris: concrete, structural steel, plant process equipment, piping, tools, miscellaneous hardware, nonasbestos-containing structural materials, Kraft paper, PPE, rags, and wood	Potential airborne and/or waterborne contamination, physical contact with process metals	Uranium, plant process equipment, and metals	Am-241, Co-60, Cs-134, Cs-137, Eu-152, Eu-154, Eu-155, H-3, Pu-238, Pu-239/240, Sr-90, U, Cd, Cr, Cu, Hg, Pb, nitric acid, sulfuric acid, fluoride
		Potential for lead-based paint coatings	Heavy metals and PCBs	Cd, Cr, Pb, PCBs
2	Visually recognized metallic wastes: uranium oxide metal cuttings; uranium metal; uranium oxides and solid metallic oxides; and machine shop metal cuttings, shavings, filings, and pieces	Process metals, physical contact with contaminated materials	Uranium, bronze crucibles, cutting oils, solid laboratory waste, metals, and contaminated gloves	Am-241, Co-60, Cs-134, Cs-137, Eu-152, Eu-154, Eu-155, H-3, Ni-63, Pu-238, Pu-239/240, Sr-90, Th, U, SVOA, VOA, Al, Be, Cd, Cr, Cu, Hg, Pb, Sn, Zr, PCBs, nitric acid, sulfuric acid, fluoride

Table 1-7. Waste Form Models and Potential Contaminants. (2 Pages)

Waste Form No.	Waste Form Model	Known or Suspected Source of Contamination	Type of Contamination (General)	Potential Contaminants (Specific)
3	Miscellaneous electrical components: control panels, wire, etc.	Electrical components and wire	Potential for surface radiological contamination	Am-241, Co-60, Cs-134, Cs-137, Eu-152, Eu-154, Eu-155, Ni-63, Pu-238, Pu-239/240, Sr-90, U
4	Asbestos-containing materials: floor tiles, ceiling tiles, pipe lagging, cement asbestos board, and gaskets	Potential airborne radioactive contamination, integral asbestos fibers in building materials	Uranium and asbestos fibers	U, asbestos fibers
5	Process soil [a]	Potentially contaminated process soil [a] (contact with buried wastes)	Radiological contamination	Am-241, Co-60, Cs-134, Cs-137, Eu-152, Eu-154, Eu-155, H-3, Ni-63, Pu-238, Pu-239/240, Sr-90, U
6	Shielding, pipe caulking	Elemental lead	Solder, pipe caulking, shielding	Pb, PCBs
7	Waste lysimeters	Solidified low-level wastes	Commercial reactor wastes	Co-60, Cs-134, Cs-137, H-3
8	ISV test melts	Vitrified waste and soil	Transuranic and fission product radionuclide staged wastes	Am-241, Co-60, Cs-137, Pu-238, Pu-239/240, Sr-90
			Metals, contaminated staged wastes, and PCBs	Cd, Pb, PCBs
9	Unknown media and waste forms	Uncontainerized unknown media, discolored process soil, containerized liquids or solids	Unknown	Unknown, but may include non-COCs
10 [b]	Suspect TRU waste	Various transuranic contaminated materials	Radiological contamination	Pu-239/240
11 [b]	Suspect spent nuclear fuel	Spent nuclear fuel rods and reactor components	Radiological contamination	Am-241, Co-60, Cs-137, Pu-238, Pu-239/240, Sr-90, U

[a] Process soil is soil that remains after removal of anomalous materials and large debris.
[b] Applied only to the 618-10 and 618-11 Burial Ground remediation.

COC = contaminant of concern
ISV = in situ vitrification
PCB = polychlorinated biphenyl
PPE = personal protective equipment
SVOA = semivolatile organic analyte
TRU = transuranic
VOA = volatile organic analyte

2.0 QUALITY ASSURANCE PROJECT PLAN

This quality assurance project plan (QAPjP) presents the objectives, functional activities, methods, and quality assurance/quality control (QA/QC) procedures associated with waste characterization and site closeout sampling for the 300 Area waste sites. Where appropriate, existing QA/QC guidelines, policies, and programs will be incorporated by reference. This QAPjP follows EPA guidelines contained in *EPA Requirements for Quality Assurance Project Plans* (EPA 2001a) and complies with the requirements of DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Documents* (HASQARD).

2.1 PROJECT MANAGEMENT

2.1.1 Project Organization

The project team for this SAP consists of the DOE-RL Project Manager, EPA Remedial Project Manager, and DOE-RL's waste site remediation contractor(s). Contractor personnel include individuals assigned to the project site as well as programmatic oversight and support personnel. Project-assigned personnel and their SAP-related duties include the following:

- Closure Operations Project Managers have overall contractor responsibility for remediation and closure of waste sites in the 300 Area industrial complex, 618-10 Burial Ground, and 618-11 Burial Ground in accordance with all requirements.

- Resident Engineers report to a project manager based on assigned area, and are responsible for implementation of technical requirements for waste site remediation, including the RDR/RAWP.

- Project Analytical Leads report to a project manager based on assigned area as well as to the programmatic Sampling and Characterization Manager, and are responsible for directing onsite measurement and sampling activities in accordance with this SAP and lower tier documents.

- Environmental Project Leads report to a project manager based on assigned area, as well as to the programmatic Environmental Compliance and Services Manager. These individuals are responsible for providing technical guidance associated with environmental regulations and reporting.

Programmatic oversight and support personnel and their SAP-related duties include the following:

- The Sampling and Characterization Manager is responsible for implementing and assessing the overall sampling, field analytical technical requirements, and laboratory technical requirements for the quality assurance program.

- Lab Services personnel report to the Sampling and Characterization Manager and are responsible for overseeing and providing interface with analytical services laboratories, including data verification and validation activities.

- Sample Shipping Leads report to the Sampling and Characterization Manager and are responsible for ensuring that samples are packaged and shipped in accordance with this SAP as well as other applicable requirements.

- The Performance and Quality Assurance Manager is responsible for overall quality monitoring and assessment of project activities.

- The Sample Design and Cleanup Verification Manager is responsible for development of site-specific verification work instructions and closure documentation in accordance with the RDR/RAWP and this SAP.

Additional responsibilities are discussed in the "Analytical Standard Operating Procedures" referenced in Appendix A and WCH-314, *Sampling and Characterization Quality Assurance Program Plan: Volume 1, Administrative Requirements; Volume 2, Sampling Technical Requirements; Volume 3, Field Analytical Technical Requirements* (S&C QAPP).

2.1.2 Problem Definition/Background

Problem definition/background has been presented in Section 1.0 of this document.

2.1.3 Quality Objectives and Criteria for Measurement Data

As developed from the DQO process, the quality objectives for the various analyses to be performed in support of waste characterization and site closeout are presented in Tables 2-1 and 2-2. Table 2-1 covers the laboratory performance requirements for all 300-FF-2 waste sites, and Table 2-2 covers the field performance requirements for 300-FF-2 waste sites. The listed methods were selected during the DQO process based on their ability to meet the quality objectives for the intended data uses (e.g., waste designation and/or site closeout) with respect to the applicable action levels.

Table 2-1. Standard Fixed Laboratory Performance Requirements. (4 Pages)

Analytes	Industrial Land-Use Cleanup Level [a] (pCi/g)	Unrestricted Land-Use Cleanup Level [a] (pCi/g)	Waste Designation Action Level [b] (pCi/g)	Analytical Method	Soil RDL (pCi/g)	Precision Req't (% RPD)	Accuracy Req't (% Recovery)
Radionuclides							
Americium-241	210	32	1	AEA	1	±30% [c]	70%-130% [c]
Cesium-137	18	4.4		GEA	0.1	±30% [c]	70%-130% [c]
Cobalt-60	5.2	1.4		GEA	0.05	±30% [c]	70%-130% [c]
Europium-152	12	3.3		GEA	0.1	±30% [c]	70%-130% [c]
Europium-154	11	3.0		GEA	0.1	±30% [c]	70%-130% [c]
Europium-155	518	125		GEA	0.1	±30% [c]	70%-130% [c]
Iodine-129	37.1 [d]	0.076		Iodine-129	2	±30% [c]	70%-130% [c]
Nickel-63	N/A	N/A		Liquid scintillation	30	±30% [c]	70%-130% [c]
Plutonium-238	155	39		AEA	1	±30% [c]	70%-130% [c]
Plutonium-239/240	245	35		AEA	1	±30% [c]	70%-130% [c]
Plutonium-241	12,900	854		Liquid scintillation	15	±30% [c]	70%-130% [c]
Strontium-90	1,970	2.3		GPC	1	±30% [c]	70%-130% [c]
Technetium-99	420 [d]	1.5		Liquid scintillation or GPC	1	±30% [c]	70%-130% [c]
Tritium (H-3)	1,980	459		Liquid scintillation	400	±30% [c]	70%-130% [c]
Uranium-233/234	167	27.2		AEA	1	±30% [c]	70%-130% [c]
Uranium-235	16	2.7		AEA	1	±30% [c]	70%-130% [c]
Uranium-238	167	26.2		AEA	1	±30% [c]	70%-130% [c]
Uranium (total)	350	56.1	N/A	KPA	1	±30% [c]	70%-130% [c]

Table 2-1. Standard Fixed Laboratory Performance Requirements. (4 Pages)

Analytes	Industrial Land-Use Cleanup Level [a] (mg/kg)	Unrestricted Land-Use Cleanup Level [a] (mg/kg)	Waste Designation Action Level [b] (mg/kg)	Analytical Method	Soil RDL (mg/kg)	Precision Req't (%RPD)	Accuracy Req't (%Recovery)
Metals							
Antimony	32	760 [d]	N/A	EPA 6010	6	±30% [e]	70%-130% [e]
Arsenic	20	20	100 [f]	EPA 6010	10	±30% [e]	70%-130% [e]
			5 mg/L [g]	EPA 1311/6010	0.5	±30% [e]	70%-130% [e]
Barium	700,000	16,000	2,000 [f]	EPA 6010	2	±30% [e]	70%-130% [e]
			100 mg/L [g]	EPA 1311/6010	10.0	±30% [e]	70%-130% [e]
Beryllium	7,000	160	N/A	EPA 6010	0.5	±30% [e]	70%-130% [e]
Cadmium	3,500	80	20 [f]	EPA 6010	0.5	±30% [e]	70%-130% [e]
			1.0 mg/L [g]	EPA 1311/6010	0.1	±30% [e]	70%-130% [e]
Chromium (total)	>1,000,000	120,000	100 [f]	EPA 6010	1	±30% [e]	70%-130% [e]
			5.0 mg/L [g]	EPA 1311/6010	0.5	±30% [e]	70%-130% [e]
Chromium VI	2.0 [d]	2.0 [d]	N/A	EPA 7196	0.5	±30% [e]	70%-130% [e]
Cobalt	1,050	24	N/A	EPA 6010	2	±30% [e]	70%-130% [e]
Copper	140,000	3,200	N/A	EPA 6010	1	±30% [e]	70%-130% [e]
Lead	1,000	250	100 [f]	EPA 6010	5	±30% [e]	70%-130% [e]
			5.0 mg/L [g]	EPA 1311/6010	0.5	±30% [e]	70%-130% [e]
Lithium	7,000	160	N/A	EPA 6010	2.5	±30% [e]	70%-130% [e]
Manganese	490,000	11,200	N/A	EPA 6010	5	±30% [e]	70%-130% [e]
Mercury	1,050	8.5 [d]	4.0 [f]	EPA 7471	0.5	±30% [e]	70%-130% [e]
			0.2 mg/L [g]	EPA 1311/7471	0.02	±30% [e]	70%-130% [e]
Nickel	70,000	1,600	N/A	EPA 6010	4	±30% [e]	70%-130% [e]
Selenium	912 [d]	302 [d]	20 [f]	EPA 6010	10	±30% [e]	70%-130% [e]
			1.0 mg/L [g]	EPA 1311/6010	0.1	±30% [e]	70%-130% [e]
Silver	17,500	400	100 [f]	EPA 6010	1.0	±30% [e]	70%-130% [e]
			5 mg/L [g]	EPA 1311/6010	0.5	±30% [e]	70%-130% [e]
Strontium	>1,000,000	48,000	N/A	EPA 6010	1	±30% [e]	70%-130% [e]
Tin	>1,000,000	48,000	N/A	EPA 6010	10	±30% [e]	70%-130% [e]
Uranium	157 [d]	81	N/A	EPA 6020	0.002	±30% [e]	70%-130% [e]

Table 2-1. Standard Fixed Laboratory Performance Requirements. (4 Pages)

Analytes	Industrial Land-Use Cleanup Level [a] (mg/kg)	Unrestricted Land-Use Cleanup Level [a] (mg/kg)	Waste Designation Action Level [b] (mg/kg)	Analytical Method	Soil RDL (mg/kg)	Precision Req't (%RPD)	Accuracy Req't (%Recovery)
Vanadium	17,500	400	N/A	EPA 6010	1	±30%[e]	70%-130%[e]
Zinc	>1,000,000	24,000	N/A	EPA 6010	1.0	±30%[e]	70%-130%[e]
Inorganics							
Chloride	N/A	N/A	N/A	EPA 300.0	2	±30%[e]	70%-130%[e]
Cyanide	42	48	590	EPA 9010	0.5	±30%[e]	70%-130%[e]
Fluoride	210,000	4,800	N/A	EPA 300.0	5	±30%[e]	70%-130%[e]
Nitrate	21,000[d]	13,600[d]	N/A	EPA 300.0	2.5	±30%[e]	70%-130%[e]
Nitrite	N/A	N/A	N/A	EPA 300.0	2.5	±30%[e]	70%-130%[e]
Sulfate	N/A	N/A	N/A	EPA 300.0	5	±30%[e]	70%-130%[e]
Sulfide	N/A	N/A	Reactivity	EPA 9030	5	±30%[e]	70%-130%[e]
Organics							
Benzo(a) pyrene	18	0.14	N/A	EPA 8310	0.015	±30%[h]	50%-150%[h]
Chrysene	1,800	14	N/A	EPA 8310	0.1	±30%[h]	50%-150%[h]
Other PAHs	Compound-specific	Compound-specific	Compound-specific	EPA 8310	Compound-specific	±30%[h]	50%-150%[h]
Hexachloro-butadiene	1,680	13	N/A	EPA 8270	0.33	±30%[h]	50%-150%[h]
Hexachloro-ethane	25	2.5	N/A	EPA 8270	0.33	±30%[h]	50%-150%[h]
Tributyl phosphate	658[d]	111	N/A	EPA 8270	3.3	±30%[h]	50%-150%[h]
Other SVOCs	N/A	N/A	Compound-specific	EPA 8270	0.66[i]	±30%[h]	50%-150%[h]
Ethylene glycol	7,770[d]	5,030[d]	N/A	EPA 8015	5	±30%[h]	50%-150%[h]
PCBs	66	0.5	50/500	EPA 8082	0.0165	±30%[h]	50%-150%[h]
VOCs	Compound-specific	Compound-specific	Compound-specific	EPA 8260	0.01[i]	±30%[h]	50%-150%[h]
TPH	2,000	2,000	N/A	WTPH-D+	5	±30%[h]	50%-150%[h]
Physical Properties							
Ignitability	N/A	N./A	60 °C (140 °F)	EPA 1010	1 °C	± 30%	70% - 130%
Corrosivity	N/A	N/A	≤2, ≥12.5	EPA 9040, 9045	0.1 pH unit	N/A	N/A

Table 2-1. Standard Fixed Laboratory Performance Requirements. (4 Pages)

Analytes	Industrial Land-Use Cleanup Level [a] (mg/kg)	Unrestricted Land-Use Cleanup Level [a] (mg/kg)	Waste Designation Action Level [b] (mg/kg)	Analytical Method	Soil RDL (mg/kg)	Precision Req't (%RPD)	Accuracy Req't (%Recovery)
Other							
Asbestos	N/A	N/A	1%	NIOSH 7400 PCM	1%	N/A	N/A

[a] Direct exposure, groundwater protection value, or river protection value (whichever is limiting) as presented in Table D-1 of the *Remedial Design Report/Remedial Action Work Plan for 300-FF-2 Soils* (DOE/RL-2014-13-ADD1).

[b] The waste designation action level is the regulatory or risk-based value to determine appropriate analytical requirements (e.g., detection limits). Units are in pCi/g or mg/kg unless otherwise specified. Land disposal restriction treatment standards for dangerous wastes may be lower than the waste designation action levels shown in Table 2-1.

[c] The precision criteria shown are for batch laboratory replicate sample RPDs. The accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for GEA analysis, additional accuracy criteria include analysis-specific evaluations preformed for matrix spike, tracer, and/or carrier recoveries as appropriate to the method.

[d] Based upon soil cleanup levels protective of groundwater/Columbia River.

[e] The precision criteria shown are for batch laboratory replicate matrix spike or replicate sample RPDs. The accuracy criteria specified are for calculated percent recoveries for associated analytical batch matrix spike samples. Additional accuracy evaluation based on statistical control limits for analytical batch laboratory control samples is also performed.

[f] Total metals analyses.

[g] TCLP metals analyses, 40 *Code of Federal Regulations* 261.24, Table 1.

[h] The precision criteria shown are for batch laboratory replicate matrix spike analysis RPDs. The accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control if more stringent. Additional accuracy criteria include analyte-specific evaluations preformed for matrix spike, and surrogate recoveries as appropriate to the method.

[i] SVOC and VOC detection limits shown are nominal maximums. Most analytes will achieve this or a lower detection limit. A limited number will have higher detection limits.

AEA = alpha energy analysis
COPC = contaminant of potential concern
EPA = U.S. Environmental Protection Agency
GEA = gamma energy analysis
GPC = gas proportional counting
KPA = kinetic phosphorescence analysis
N/A = not applicable
NIOSH = National Institute for Occupational Safety and Health
PAH = polycyclic aromatic hydrocarbon
PCB = polychlorinated biphenyl
PCM = phase contrast microscopy
RDL = required detection limit
RPD = relative percent difference
SVOC = semivolatile organic compound
TPH = total petroleum hydrocarbon
TCLP = toxic characteristic leachate procedure
VOC = volatile organic compound
WTPH-D = Washington total petroleum hydrocarbon-diesel

Table 2-2. Field Screening Performance Requirements for 300-FF-2 Waste Sites. (2 Pages)

Analyte	Waste Designation Action Levels [a] (mg/kg)	Analytical Method	Detection Limit Goals [b]	Precision	Accuracy
Field Screening Measurements – RCF Samples					
Cesium-137	N/A	GEA (at RCF)	0.5	±50%	±50%
Cobalt-60	N/A	GEA (at RCF)	0.5	±50%	±50%
Europium-152	N/A	GEA (at RCF)	1.0	±50%	±50%
Europium-154	N/A	GEA (at RCF)	1.0	±50%	±50%
Europium-155	N/A	GEA (at RCF)	1.0	±50%	±50%
Gamma speciation	N/A	Portable HPGe detector and passive neutron detector	N/A	N/A	N/A
Gross alpha	N/A	Portable contamination detector	100 dpm/ 100 cm^2	N/A	±50%
Gross beta/gamma	N/A	Portable contamination detector	5,000 dpm/ 100 cm^2	N/A	±50%
Suspect spent nuclear fuel	N/A	CRATER™ (see WCH-305)	Detect/ nondetect	TBD by vendor	TBD by vendor
Transuranic, Pu isotopes	N/A	Mobile nondestructive assay system [c]	Meet CWC and WIPP waste acceptance criteria [c]	≥16% Relative standard deviation [c]	40%-160% [c]
Field Screening Measurements – Chemical					
Arsenic	100 [c]	Field laboratory XRF	71	TBD	TBD
Barium	2,000 [c]	Field laboratory XRF	300	TBD	TBD
Cadmium	20 [c]	Field laboratory XRF	52	TBD	TBD
Chromium (total)	100 [c]	Field laboratory XRF	282	TBD	TBD
Lead	100 [c]	Field laboratory XRF	99	TBD	TBD
Selenium	20 [c]	Field laboratory XRF	190	TBD	TBD
Silver	100 [c]	Field laboratory XRF	89	TBD	TBD
VOC	Compound-specific	OVA/OVM	Qualitative	N/A	N/A
pH	≤2 or ≥12.5	Litmus	Qualitative	N/A	N/A

Table 2-2. Field Screening Performance Requirements for 300-FF-2 Waste Sites. (2 Pages)

Analyte	Waste Designation Action Levels [a] (mg/kg)	Analytical Method	Detection Limit Goals [b]	Precision	Accuracy
Radiological Surveys					
Uranium	Unlimited	Field survey	75 pCi/g	±35%	70%-150%

[a] The waste designation action level is the regulatory or risk-based value to determine appropriate analytical requirements (e.g., detection limits).

[b] Units are in pCi/g or mg/kg, unless otherwise specified. Detection limits shown are for standard fixed laboratory methods for low contamination soils. Significant levels of contamination may affect achievable detection limits due to the need to reduce sample sizes, increase dilution, or due to interference effects.

[c] See DOE/CBFO-01-1005, *Performance Demonstration Program Plan for Nondestructive Assay of Drummed Wastes for the TRU Waste Characterization Program.*

[d] SW-846 Method 1311, TCLP, Section 1.2 (EPA 1997).

CWC = Central Waste Complex
CRATER™ = Compton Ratio Analysis Testing for Environmental Radioactivity
GEA = gamma energy analysis
HPGe = high-purity germanium
N/A = not applicable
OVA = organic vapor analyzer
OVM = organic vapor monitor
RCF = Radiological Counting Facility
TBD = to be determined
TCLP = toxic characteristic leachate procedure
VOC = volatile organic compound
WIPP = Waste Isolation Pilot Plant
XRF = x-ray fluorescence

2.1.4 Special Training Requirements/Certification

Training or certification requirements needed by personnel are described in the HASQARD (DOE/RL-96-68) and in BSC-1, *Business Services and Communications,* Section 2.0, "Training." Field personnel shall have completed the following mandatory training before starting work:

- Occupational Safety and Health Administration 40-Hour Hazardous Waste Worker Training
- Radiation Worker Training
- Hanford General Employee Training.

Personnel conducting sampling, radiological surveys, and chemical field screening shall meet additional training and certification requirements as specified in the S&C QAPP.

2.1.5 Documents and Records

This SAP and associated laboratory and field documentation shall be kept in accordance with the requirements of the HASQARD (DOE/RL-96-68), the S&C QAPP, and standard operating procedures (SOPs) listed in Appendix A.

2.2 MEASUREMENT/DATA ACQUISITION

The following section presents the requirements for sampling methods, sample handling and custody, analytical methods, and QC (field and laboratory). Requirements for instrument calibration and maintenance, supply inspections, and data management are also addressed. Applicable SOPs are listed in Appendix A.

2.2.1 Sampling Design

A summary of the sampling designs for waste characterization and site closeout is presented in Section 1.0. The field sampling plan (FSP) in Section 3.0 presents additional details, summary tables, and figures that address sampling procedures, sampling locations, sampling frequencies, and analytical methods.

2.2.2 Sampling Methods

The sampling procedures that will be used during implementation of this SAP are outlined in the FSP in Section 3.0.

2.2.3 Sample Handling and Custody Requirements

The sample handling and custody requirements are identified in the FSP in Section 3.0.

2.2.4 Analytical Method Requirements

Analytical parameters and methods are listed in Tables 2-1 and 2-2. Laboratory-specific SOPs for the analytical methods are in place or will be prepared, as necessary. An overview of proposed methods for the 300 Area waste sites is presented in the following subsections. Changes to or addition of methods identified in this SAP will be implemented in page changes, addenda, or revisions to this SAP, as appropriate.

2.2.4.1 Field Screening and Radiological Surveys (General). Chemical field screening and radiological surveys used to support waste characterization and site closeout activities will be performed in accordance with HASQARD (DOE/RL-96-68); the S&C QAPP; and procedures specified in ENV-1, *Environmental Monitoring & Management*, ENV-1-2.24, "Routine Field Screening" (Appendix A).

2.2.4.2 Field Screening and Radiological Surveys. The instruments used for initial screening of waste may include gamma radiation rate meters, infrared sensors, and photoionization detectors. Soils and debris may be screened for radiation dose rates with an excavator-mounted gamma detector. Further screening of soils and debris exhibiting elevated dose rates may be performed using the Compton Ratio Analysis Testing for Environmental Radioactivity (CRATER™) system. The resident engineer will determine which items will be surveyed with the CRATER™ system. The analytical specifications for the CRATER™ system are documented in WCH-305, *Screening Excavated Soils for Spent Fuel Fragments Using a*

Compton to Cs-137 Photopeak Ratio Methodology. Drums encountered may be further screened using an Ortec® Detective-EX (high-purity germanium gamma-ray spectrometer) and a shielded passive neutron detector. Metal encountered may be screened using an INNOV-X-Systems© x-ray fluorescence (XRF) spectrometer. A field portable nondestructive assay (NDA) system may be deployed to determine if TRU waste streams are present, requiring disposition through the Central Waste Complex. The NDA system is designed to meet the waste acceptance requirements for the Central Waste Complex. In addition to the NDA system, a field portable and/or fixed facility real-time radiography system may be used to identify liquids and anomalous items contained in concrete and concrete/lead-shielded drums. Field-screening performance requirements are specified in Table 2-2.

2.2.4.3 Radiological Counting Facility. Samples submitted to the Radiological Counting Facility will be analyzed in accordance with applicable procedures. The Radiological Counting Facility procedures are referenced in Appendix A.

2.2.4.4 Standard Fixed Laboratory Analyses. The standard fixed laboratory (SFL) analyses will be used for all verification samples and will be performed in accordance with the reference methods identified in Table 2-1 and the associated laboratory SOPs.

2.2.5 Quality Control Requirements

Quality control procedures must be followed in the field and in the laboratory to ensure that reliable data are obtained. When performing this field sampling effort, care shall be taken to prevent cross-contamination of sampling equipment, sample bottles, and other equipment that could compromise sample integrity. Field QC requirements are outlined in Section 3.0. Laboratory QC requirements are established in the reference analytical methods and associated SOPs to include the following elements:

- Specific QC procedures
- Level of effort (frequency)
- QC limits
- Corrective action requirements.

2.2.6 Instrument/Equipment Testing, Inspection, and Maintenance Requirements

All onsite environmental instruments used for waste characterization and site closeout shall be inspected, tested, and maintained in accordance with the HASQARD (DOE/RL-96-68) and the S&C QAPP. Laboratory inspection and maintenance requirements shall be performed in accordance with the manufacturer instructions and the applicable QA plan.

2.2.7 Instrument Calibration and Frequency

Field screening and radiological survey instruments used for waste characterization and site closeout activities shall be calibrated or instrument response checked in accordance with the HASQARD (DOE/RL-96-68) and the S&C QAPP. The results from calibration and response check activities shall be recorded in a logbook, which shall meet the requirements of the HASQARD (DOE/RL-96-68). Calibration of laboratory instruments shall be performed in accordance with the manufacturer instructions and the applicable QA plan.

2.2.8 Inspection/Acceptance Requirements for Supplies and Consumables

Received items and reagents will be inspected for conformance with specifications set in the procurement requisition. If the items or reagents do not meet specifications, the items/reagents will be dispositioned through the nonconformance system (e.g., BSC-1, Section 4.0, "Procurement").

Acceptability of new standards will be determined by comparing the new standard with previous acceptable standards. Reagent acceptability will be determined by running blanks on the new reagents. New reagents and standards will be separated from other standards and reagents until they have been checked and accepted.

2.2.9 Data Acquisition Requirements (Nondirect Measurements)

Nondirect data are obtained from three database/information management systems, which are the Waste Information Data System database, the Hanford Geographic Information System, and the Hanford Environmental Information System (HEIS) database. The Waste Information Data System database is the official Hanford Site resource for waste site name, waste type, site description, past-practice history, and documentation available for each waste site, including documents, drawings, and photographs. The Hanford Geographic Information System is used to maintain the baseline maps for the Hanford Site. Maps of the waste sites, facilities, services, and key environmental features are maintained. The HEIS database is used to maintain electronic access to the available chemical and radiological analytical data for the Hanford Site waste sites and for the Hanford Site groundwater.

2.2.10 Data Management

The sample and data management process will be used to manage onsite high-purity germanium, quick-turnaround laboratory, and SFL analyses and process data to develop data tables and maps to guide the remediation. The data process control system will also be used to obtain and communicate data results to support interim closure decision. Verification data are stored in the project-specific database and uploaded into the HEIS database.

Data resulting from the implementation of this SAP will be managed and stored by the Washington Closure Hanford (WCH) Sample Management organization and shall meet the requirements of the HASQARD (DOE/RL-96-68).

All analytical data packages shall be subject to final technical review by qualified reviewers before submittal to regulatory agencies or inclusion in reports/technical memoranda, at the direction of the WCH project manager. When appropriate, electronic access shall be through computerized databases (e.g., Stewardship Information System, HEIS). Where electronic data are not available, hard copies will be provided in accordance with Section 9.6 of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989).

2.2.11 Sample Preservation, Containers, and Holding Times

The requirements for sample preservation, containers, and holding times are presented in the FSP (Section 3.5).

2.2.12 Field Documentation

The field documentation requirements are presented in the FSP (Section 3.5).

2.3 ASSESSMENT/OVERSIGHT

2.3.1 Assessments and Response Actions

The WCH QA staff may conduct random surveillance and assessment activities to verify compliance with the requirements outlined in this SAP, the project work packages, the WCH Quality Management Plan, WCH procedures, and regulatory requirements. Deficiencies identified during surveillance or assessment activities shall be reported in accordance with contractor self-assessment procedures (e.g., QA-1, *Quality Assurance*, QA-1-1.5, "Self Assessments"). Corrective action required as a result of surveillance or assessment activities shall be documented and dispositioned in accordance with contractor corrective action management procedures (e.g., QA-1-1.2, "Corrective Action Management").

2.3.2 Reports to Management

All findings from audits, surveillance, and assessments will be transmitted to the project manager and the WCH QA department for program-related tracking and trending.

2.4 DATA VALIDATION AND USABILITY

2.4.1 Data Review, Validation, and Verification Requirements

A minimum of 5% of verification data packages will be validated. All coordination of validation services, execution of data validation activities, and handling/storage of deliverables will be performed in accordance with contractor data package validation procedures (e.g., ENV-1-2.12, "Data Package Validation"). Data validation will be performed in accordance with BHI-01433, *Data Validation Procedure for Radiochemical Analysis*, and BHI-01435, *Data Validation Procedure for Chemical Analysis*. The validated data results, including applicable qualifiers, shall be entered into the HEIS database. Routine data verification shall be performed in accordance with sample documentation processing procedures (e.g., ENV-1-2.11, "Sample Documentation Processing).

Onsite measurements and quick-turnaround analysis data will not undergo a formal validation. The QA/QC processes used in SOPs will be followed to ensure useable data. These include the use of blanks, duplicates, splits, and measurement of known standards. The data will be reviewed by analytical personnel and the project team.

2.4.2 Data Quality Assessment

A data quality assessment of the verification sample results will be performed to verify suitability for their intended purpose to support site closeout. The data quality assessment shall include a review of the applicable data validation results and laboratory data set (including field QC results) set with respect to the PARCC parameters (i.e., precision, accuracy, completeness, representativeness, and comparability). As a minimum, the laboratory QA/QC data shall be evaluated for adequacy to meet the requirements for precision, accuracy, completeness, and target detection limits as defined below.

2.4.2.1 Precision. If calculated from duplicate measurements:

$$RPD = \frac{(C_1 - C_2) \times 100}{(C_1 + C_2)/2} \tag{1}$$

where:

RPD = relative percent difference
C_1 = larger of the two observed values
C_2 = smaller of the two observed values.

If calculated from three or more replicates, use relative standard deviation rather than the relative percent difference (RPD):

$$RSD = (s/\bar{y}) \, x \, 100 \tag{2}$$

where:

RSD = relative standard deviation
s = standard deviation
$\bar{y}$ = mean of replicate analyses.

Standard deviation, s, is defined as follows:

$$s = \sqrt{\sum_{i=1}^{n} \frac{(y_i - \bar{y})^2}{n-1}} \tag{3}$$

where:

s = standard deviation
y_i = measured value of the i^{th} replicate
$\bar{y}$ = mean of replicate measurements
n = number of replicates.

2.4.2.2 Accuracy. For measurements where matrix spikes are used:

$$\%R = 100\,x \left[\frac{S - U}{C_{sa}} \right] \tag{4}$$

where:

%R = percent recovery
S = measured concentration in spiked aliquot
U = measured concentration in unspiked aliquot
C_{sa} = actual concentration of spike added.

For situations where a standard reference material is used instead of or in addition to matrix spikes:

$$\%R = 100\,x \left[\frac{C_m}{C_{srm}} \right] \tag{5}$$

where:

%R = percent recovery
C_m = measured concentration of standard reference material
C_{srm} = actual concentration of standard reference material.

2.4.2.3 Completeness. Defined as follows for all measurements:

$$\%C = 100\,x \left[\frac{V}{T} \right] \tag{6}$$

where:

%C = percent completeness
V = number of measurements judged valid
T = total number of measurements.

2.4.2.4 Detection Limit. Defined as follows for chemical measurements:

$$MDL = t_{(n-1,\,1-\alpha = 0.99)}\, x\, S \tag{7}$$

where:

MDL	=	method detection limit
S	=	standard deviation of the replicate analyses
$t_{(n-1,\,1-\alpha=0.99)}$	=	students' t-value appropriate to a 99% upper confidence limit and a standard deviation estimate with n-1 degree of freedom.

For radionuclides, the method detection limit will be per Currie calculations (Currie 1968).

2.4.2.5 Data Qualifiers. Data flagged as estimated indicate that the associated concentration is an estimate but the data are useable for decision-making purposes. Data flagged as below detection limits (i.e., "U") indicate that the analyte was analyzed for but not detected, and the concentration shown is the minimum detectable activity for radionuclides and the practical quantitation limit for nonradionuclides. Data flagged as rejected (i.e., "R") indicate that the data are not useable due to a QA/QC deficiency. All other validated results are considered accurate within the standard errors associated with the methods.

3.0 FIELD SAMPLING PLAN

This FSP describes the requirements and procedures used for sample collection, radiological surveys, chemical field screening, and laboratory analyses to support verification of profiled waste, waste characterization, and site closeout activities. Additional sampling guidance will be found in the site-specific work instructions for verification sampling.

The environmental measurement and sample management common elements of the FSP that apply to both waste characterization sampling and site closeout sampling are summarized in the following subsections.

The technical requirements for sampling and field analyses are found in Volumes 1, 2, and 3 of HASQARD and the S&C QAPP. Technical requirements for laboratories are found in Volumes 1 and 4 of HASQARD (DOE/RL-96-68). The project is responsible to ensure the use of appropriate procedures based on the intended data use. Within the scope of the SAP, radiological surveys are used to guide the excavation and support waste verification, characterize waste, and prepare for site closeout sampling. The relevant use for these survey applications are discussed below.

- Radiological surveys used to guide excavation activities and to verify waste profiles will be performed. Survey instruments are operated and maintained in accordance with operating and maintenance procedures. At the direction of the project, samples and/or smears may be collected and analyzed at the Radiological Counting Facility in accordance with applicable procedures to supplement radiological survey data.

- Radiological surveys used for waste characterization may be performed at the direction of the project to supplement sampling and laboratory analytical data. Requirements (e.g., survey design, static measurements) for waste characterization surveys (if used) will be prepared and approved by the WCH Waste Services organization.

- Radiological surveys used to evaluate if a site has been sufficiently excavated and is ready for site verification sampling will be performed by following the S&C QAPP requirements. Specific radiological survey design requirements, which include survey coverage and measurement locations, will be specified in an environmental radiological survey task instruction and will be reviewed by appropriate management personnel prior to issuing and implementing.

3.1 SAMPLING OBJECTIVES

The sampling objectives for waste characterization for material unearthed from the 300-FF-2 waste sites are to determine the following attributes:

- If soil and debris meets the Environmental Restoration Disposal Facility waste acceptance criteria (WCH-191)
- Applicability of characteristic waste codes (*Washington Administrative Code* [WAC] 173-303-90)
- If the waste meets the definition of a toxic dangerous waste (WAC 173-303-100)
- If the waste meets the definition of a dangerous persistent waste (WAC 173-303-100)
- If the waste is regulated due to polychlorinated biphenyl concentrations (40 *Code of Federal Regulations* (CFR) 761, WAC 173-303)
- If the waste is regulated due to asbestos content (40 CFR 61 Subpart M)
- If the waste is regulated as TRU
- If the waste is regulated as spent nuclear fuel.

The objectives for site closeout (verification) sampling are to demonstrate that the remedial action cleanup levels identified in the RDR/RAWP Soil Addendum (DOE/RL-2014-13-ADD1) have been met for residual soil in the excavation area, stockpiled overburden/layback soil that is intended for use a backfill material, the general area of contamination, and residual soil in staging pile areas (if applicable). The cleanup verification sampling process developed in the DQO summary report (BHI-01501, EPA 2006) is a multi-faceted approach that consists of the following elements:

- For radiologically contaminated waste sites, radiological surveys are performed after removal of buried waste and co-mingled soil or staged waste to provide an initial indication that residual soil contamination levels meet radiological cleanup levels.
- In-process, focused sampling is used to provide confidence for the absence of "hot spots" in residual soil beneath areas where contaminated materials were removed or staged during the excavation process. In-process samples may be analyzed for radionuclides and/or chemical constituents at the Radiological Counting Facility and/or offsite laboratories.
- Site verification sampling is used to verify (through evaluation of resulting data sets in accordance with the RDR/RAWP Soil Addendum) that residual soil from the excavation floor/sidewalls, stockpiled overburden/layback soil intended for use as backfill, the area of contamination, and residual soil in staging pile area footprints (if applicable) meet the cleanup levels. Specific sampling guidance for individual waste site closeout using statistical and/or focused sampling approaches will be provided in site-specific work instructions.

3.2 SAMPLING LOCATIONS AND FREQUENCIES

The following subsections describe sampling locations and frequencies for waste characterization and site closeout separately.

3.2.1 Waste Characterization Sampling Locations and Frequencies

Waste unearthed from the 300-FF-2 waste sites may or may not require characterization to support waste designation. As a minimum, radiological surveys will be needed for all waste to verify the waste profile and support U.S. Department of Transportation shipping requirements. The following three categories of waste exist from a designation standpoint:

- Wastes conforming to the WFMs (and/or process soil) that may be designated without additional characterization and that do not require special handling for human exposure or waste acceptance.
- Wastes conforming to the WFMs (and/or process soil) that may be designated without additional characterization but that do require special handling for human exposure or waste acceptance. Waste types in this category include (but are not limited to) lead bricks, cadmium shielding, and friable asbestos-containing materials.
- Wastes that cannot be designated without additional characterization and that may also require special handling for human exposure protection or waste acceptance. Unknown anomalous materials are included in this category.

Project personnel and the Waste Services representative shall determine the category that is appropriate for the various wastes. Specific sampling locations for waste materials that require characterization to support designation will be chosen by project personnel and the Waste Services representative. Because the locations are not specified, field decisions must be made based on available information. General locations of metallic debris, land disposal restricted waste (e.g., lead bricks), asbestos material, discolored soil, and/or anomalous waste that are characterized for waste designation will be noted so that in-process sampling may be performed as a component of excavation guidance. Sampling frequencies are shown in Table 3-1 for the various WFMs that have been identified. Note that WFMs 10 and 11 listed in Tables 1-2 and 3-1 apply only to the 618-10 and 618-11 Burial Ground remediation.

The specific analyses required for sampling an anomalous waste will be determined by the project on a case-by-case basis. The determination will be made using an anomaly characterization checklist.

Table 3-1. Waste Characterization Sampling Design. (2 Pages)

WFM #	Media	Sample Collection Methodology	Key Features/ Sampling Frequency	Basis for Sampling Design
1	Demolition debris: concrete, structural steel, process equipment, piping, tools, miscellaneous hardware, nonasbestos-structural materials, Kraft paper, PPE, rags, and wood	Contingency lead paint sampling.	If sampling is required, collect one composite sample per paint color discovered.	Use historical data for previously characterized paint colors. If data do not exist, perform engineering matrix calculation or sample painted surfaces for heavy metals.
2	Visually recognized metallic wastes: uranium oxide metal, solid metallic oxides; machine shop metal cuttings, shavings, and filings	No sampling required unless external contamination observed.	Use historical data and process knowledge.	Well-known and previously designated waste forms.
3	Electrical components: control panels, wire, etc.	No sampling required unless external contamination observed.	Use historical data and process knowledge.	Well-known and previously designated waste forms.
4	Asbestos-containing materials: floor tiles, ceiling tiles, pipe lagging, cement asbestos board, and gaskets	No sampling is required.	Designate as asbestos without sampling.	Process knowledge/visual observation sufficient for waste designation.
5	Process soil [a]	Metals screen.	Determined by resident engineer or waste specialist.	Observation based: to ensure conformance to waste disposal parameters (e.g., profile and waste designation).
6	Shielding, pipe caulking	No sampling required unless external contamination observed.	Use historical data and process knowledge.	Well-known and previously designated waste forms.
7	Waste lysimeters	No sampling required.	Use historical characterization data.	Waste lysimeters were characterized in PNL-8955.
8	ISV test melt (radiologically contaminated)	No sampling required.	Use historical characterization data.	Waste was characterized in PNL-5240.
	ISV test melt (chemically contaminated)	Characterize from historical data, or sample.	Designate melts with Cd and Pb based on historical TCLP data. Otherwise, establish sampling requirements with project and waste management representatives.	Need to accumulate historical ISV test records that link locations of specific melts.

Table 3-1. Waste Characterization Sampling Design. (2 Pages)

WFM #	Media	Sample Collection Methodology	Key Features/ Sampling Frequency	Basis for Sampling Design
9	Uncontainerized unknown media, containerized liquids or solids	Establish requirements with project and waste management representatives.		
	Discolored soil	In situ OVA, metals screen.	One sample per 3.8 m^3 (5 yd^3) of discolored soil.	Observation based: color changes, leaking containers, radiological surveys, hazardous solid materials (e.g., lead bricks), and other.
		Sampling for offsite analysis.	One sample from location of high field screening results.	Waste designation. Analyses could include total metals, TCLP, or volatile organics suite. Other analyses may be needed.
10 [b]	Suspect TRU waste	Onsite NDA.	NDA each suspect item.	Based on process knowledge.
11 [b]	Suspect spent nuclear fuel	Onsite gamma spectroscopy.	Characterize each suspect item.	Based on process knowledge.

[a] Process soil is co-mingled soil after sorting to remove anomalous materials.
[b] Applied only to the 618-10 and 618-11 Burial Ground remediation.

ISV = in situ vitrification
NDA = nondestructive assay
OVA = organic vapor analyzer
PPE = personal protective equipment
TCLP = toxic characteristic leachate procedure
TRU = transuranic
WFM = waste form model

Visual observations combined with historical data, process knowledge, and engineering calculations can result in a cost-effective and expeditious waste designation. The observational designation process is based on the assumption that the buried waste did not change after disposal. However, it is recognized that containers of liquids may have leaked, causing dangerous/hazardous materials to come into contact with buried solid wastes, or contaminated soils may have been disposed in the burial grounds. Consequently, field radiological surveys and chemical screening of the co-mingled soil may be necessary during excavation.

After the waste sorting process is complete and anomalous waste forms are removed, the co-mingled soil will be referred to as "process soil." Process soil samples will be taken as determined by the resident engineer or waste specialist to verify disposal profile parameters and to designate the waste. Samples for metals screening will be delivered to a contract laboratory for metals analysis. Samples for radionuclide screening will be delivered to an onsite counting facility for analysis. An offsite EPA-approved laboratory may be used for additional analysis if required. Soils outside of burial trenches proper are not considered to be "process soil."

Sampling with organic vapor analyzer (OVA) instrumentation will also be performed to detect organic vapors at sampling sites when soil samples are taken. Monitoring requirements for organic vapors using the OVA are specified by the health and safety plan in consideration of contaminants that are expected at the site. Samples for laboratory analysis are collected as needed to evaluate OVA measurements. If positive OVA results are obtained, a soil sample may be collected from the contaminated location for laboratory analysis or headspace analysis in a gas chromatograph.

In addition to the in-process screening (as described above), visual observation of discoloration, leaking containers, hazardous solid materials (e.g., lead bricks), or other anomalous material in the dig face or process soil will be used to conduct field screening. The same techniques (OVA and metals screening) will be used for observational screening when determined necessary by the resident engineer or waste specialist.

The proposed screening methods (i.e., radiological surveys, OVA, and metals by XRF or contract laboratory) provide detection of the radiological and chemical constituents that pose waste designation concerns. However, certain constituents are not detectable by these techniques, including mercury and semivolatile organic compounds. In addition, the XRF detection capabilities for cadmium and selenium may not be within the desired range (i.e., land disposal restricted threshold totals values), but these limitations do not prevent the use of screening methods. In the case of mercury, it is only expected to be present with mercury-containing piping and equipment, which is not one of the 300 Area WFMs. Cadmium, if present, is expected in detectable concentrations, and selenium is not expected to exist above background levels in the burial grounds.

Screening results that exceed the dangerous/hazardous waste limits will initiate project decision making. Depending on the volume of anomalous soil and the detected values, additional sampling may be initiated for laboratory analysis (e.g., toxicity characteristic leachate procedure), or the project may assign the appropriate waste code and ship the anomalous soil for treatment and disposal. If the project elects to sample for laboratory analysis, one sample should be collected from the location with the highest screening results. The results of the laboratory analysis will be used to determine if the soil is designated as dangerous/hazardous waste. Figure 3-1 provides a logic flow diagram for disposition of buried waste and co-mingled soil. Figure 3-2 provides a logic flow diagram for disposition of anomalous waste forms.

As characterization data are collected and specific types of anomalous wastes are repeatedly discovered during remediation, the waste types could be candidates to become new WFMs. Decisions to identify a new WFM will be based on concurrence between project personnel and the WCH Waste Services representative.

Figure 3-1. Logic Flow Diagram for Disposition of Buried Waste and Co-Mingled Soil.

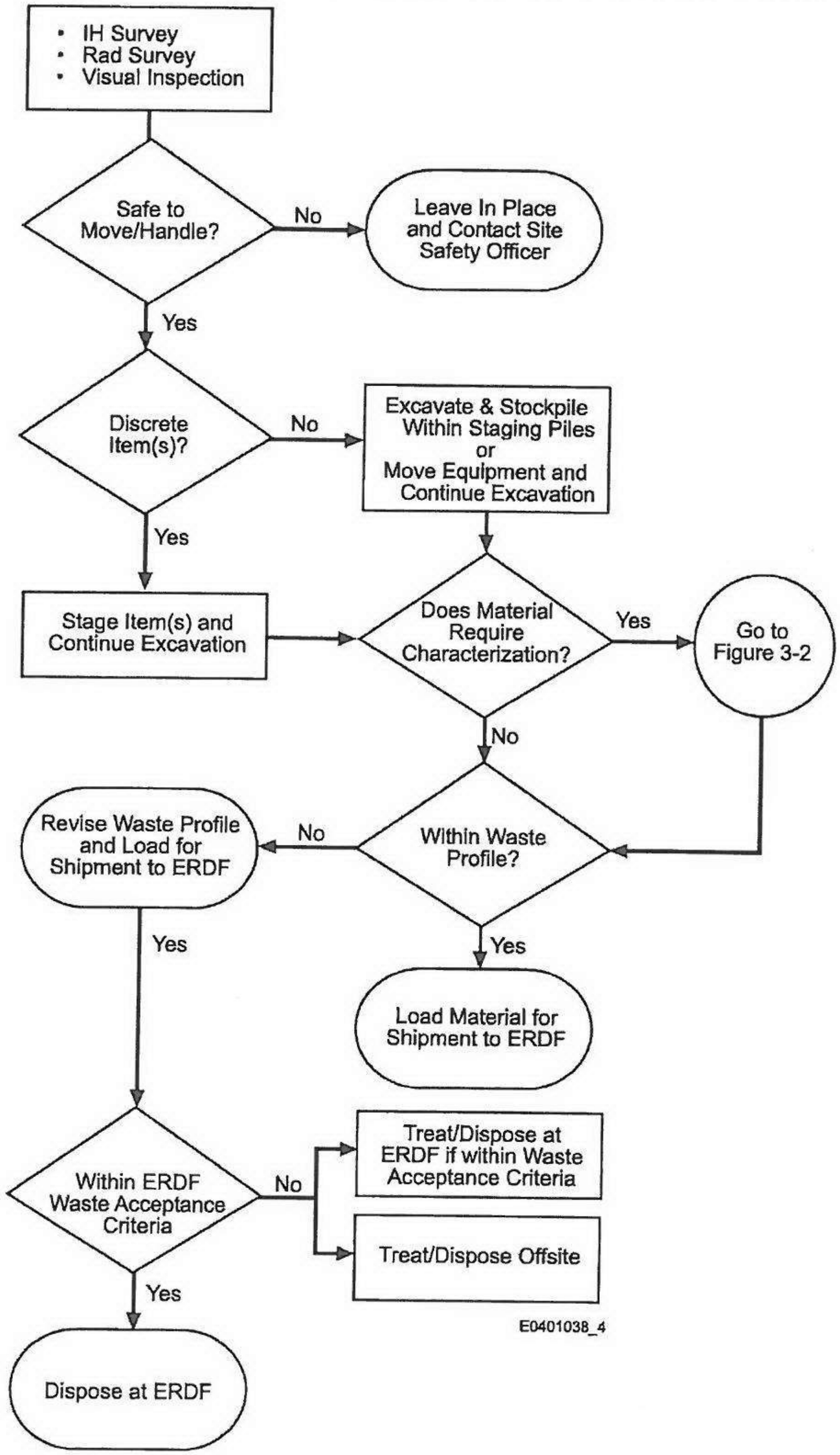
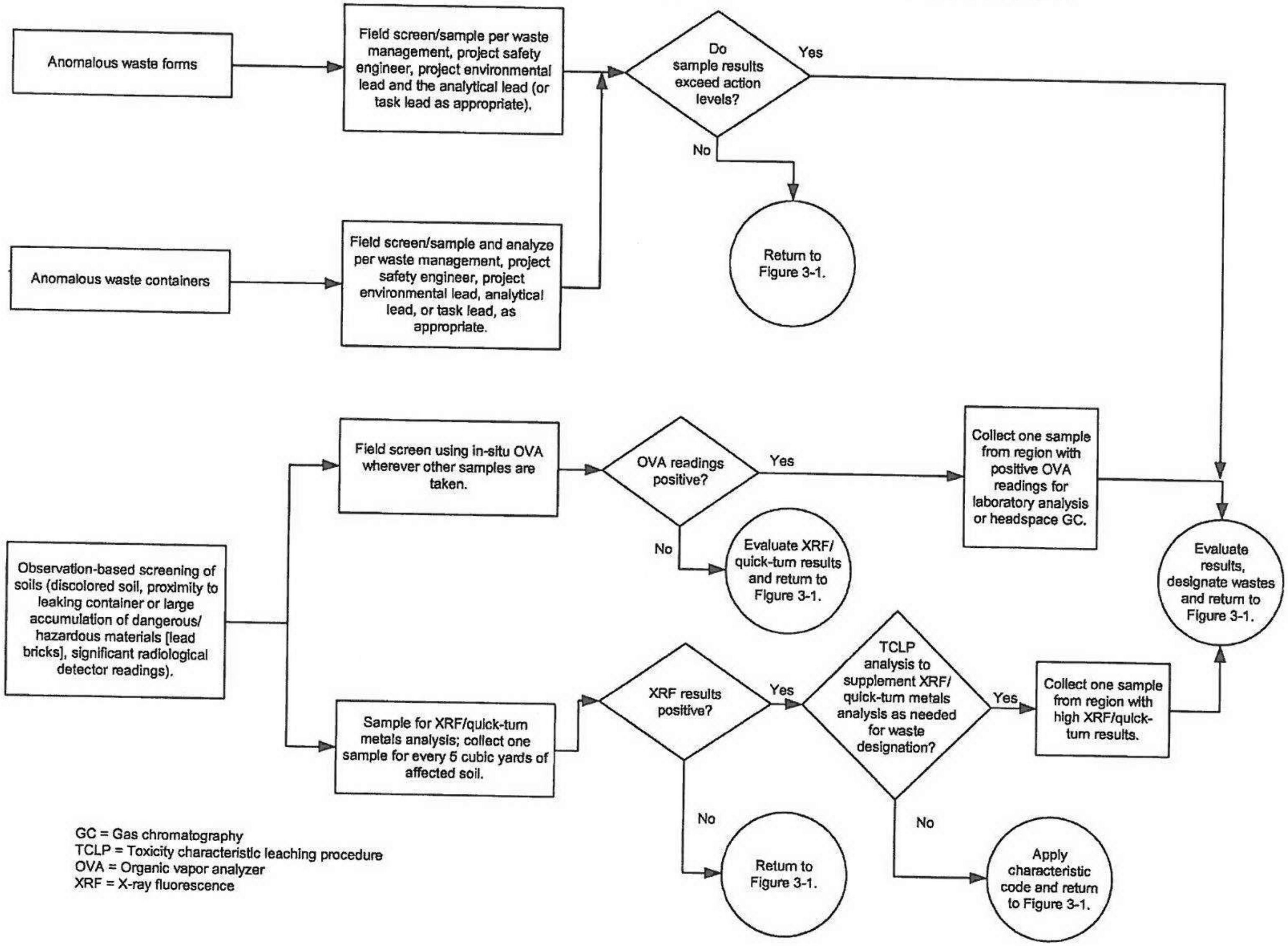


Figure 3-2. Logic Flow Diagram for Disposition of Anomalous Waste Forms.



GC = Gas chromatography
TCLP = Toxicity characteristic leaching procedure
OVA = Organic vapor analyzer
XRF = X-ray fluorescence

3.2.2 Site Closeout Sampling Locations, Frequencies, and Methods

The site closeout sampling locations, frequencies, and methods were developed in the DQO (BHI-01501, EPA 2006) and are summarized in the following subsections.

3.2.2.1 Radiological Surveys and In-Process Sampling. Radiological survey and in-process sampling frequencies are summarized in Table 3-2. At radiologically contaminated sites, radiological surveys will be performed after removal of buried waste and co-mingled soil to provide an initial indication that residual soil contamination levels meet radiological cleanup levels. The radiological surveys may be performed using hand-held, backpack, and/or cart-mounted equipment that is configured to detect the desired radionuclides.

Table 3-2. Site Closeout Sampling Design. (2 Pages)

Sampling Objectives	Number of Samples	Basis
Excavation guidance – radiological surveys	In situ surveys; no discrete samples.	Excavation continues until radiological levels meet survey criteria, indicating that verification sampling should demonstrate CULs are met.
Excavation guidance – in-process sampling	One grab sample beneath locations that had buried liquid wastes, hazardous wastes (e.g., lead bricks), and from areas where waste characterization results showed chemical and/or radiological concentrations above the applicable cleanup levels based on anticipated land use for the site.	Excavation continues until chemical and radiological cleanup levels are met, indicating that verification sampling should demonstrate CULs are met.
Verification – shallow zone (0 to 4.6 m [0 to 15 ft])	Based on site-specific information, stratify excavation into decision units as needed. For statistical sampling, collect a minimum of 12 statistical soil samples using a systematic grid per decision unit. Focused samples located as needed within the excavated area.	Shallow zone cleanup verification samples for evaluation in accordance with the RDR/RAWP Soil Addendum (DOE/RL-2014-13-ADD1).
Verification – deep zone (>4.6 m [>15 ft])	Based on site-specific information, stratify excavation into decision units. For statistical sampling, collect a minimum of 12 statistical soil samples using a systematic grid. Focused samples located as needed within the excavated area.	Deep zone cleanup verification samples for evaluation in accordance with the RDR/RAWP Soil Addendum (DOE/RL-2014-13-ADD1).
Overburden/layback piles	Based on site-specific information, stratify overburden/layback soil piles into decision units. For statistical sampling, collect a minimum of 12 statistical soil samples using a systematic grid per decision unit. Nonstatistical sampling designs may be approved in site-specific sampling instructions. Samples are collected from the surface of stockpiled soils.	Overburden verification samples for evaluation in accordance with the RDR/RAWP Soil Addendum (DOE/RL-2014-13-ADD1).

Table 3-2. Site Closeout Sampling Design. (2 Pages)

Sampling Objectives	Number of Samples	Basis
Staging pile areas (residual soils)	Based on site-specific information, stratify staging pile area into decision units. For statistical sampling, collect a minimum of 12 statistical soil samples using a systematic grid per decision unit. Nonstatistical sampling designs may be approved in site-specific sampling instructions.	Staging pile closeout samples for evaluation in accordance with the RDR/RAWP Soil Addendum (DOE/RL-2014-13-ADD1).

CUL = cleanup level
RDR/RAWP = remedial design report/remedial action work plan

After radiological survey criteria have been met, in-process samples of residual soil may be collected from beneath locations that had visual stains, buried liquid wastes, large inventories of hazardous wastes (e.g., lead bricks), and from areas where characterization results showed elevated contaminant concentrations. In-process sampling will consist of surface grab sample collection and SFL analysis of chemical and/or radiochemical constituents in accordance with selected methods identified in Table 2-1. The proposed scope (e.g., specific sample locations and constituents to be analyzed) of in-process sampling events will be identified by the project and implemented with concurrence from DOE and EPA.

Where in-process sampling results indicate that residual soil exceeds the applicable cleanup levels based on the anticipated land use for the site (i.e., industrial or unrestricted), additional excavation will be performed and the area will be resampled. This process will be repeated until the applicable cleanup levels have been met. In-process sampling locations and associated results will be reported in closeout documents (e.g., cleanup verification package) but will not be used for final compliance evaluations. Cleanup verification sampling results will be evaluated separately to demonstrate attainment of the cleanup levels.

3.2.2.2 Site Verification. Following completion of excavation guidance sampling, site verification sampling will be initiated as specified in site-specific work instructions for verification sampling. The following decision units will be considered during the site verification sampling process:

- Shallow zone of the excavated site, which is defined as the residual soil 0 to 4.6 m (0 to 15 ft) below the surrounding grade
- Deep zone of the excavated site, which is defined as the residual soil greater than 4.6 m (15 ft) below the surrounding grade
- Overburden/layback, which includes stockpiled soil that was segregated from contaminated materials during the excavation process with the intention of using it as backfill

- Residual soil in staging pile area footprints where contaminated soil and materials were previously staged during the excavation process in accordance with the provisions specified in the 300 Area RDR/RAWP (DOE/RL-2014-13-ADD1).

A general summary of the site verification sampling frequencies and the associated basis for each of the decision units is presented in Table 3-2. Where a statistical sampling design is utilized, a minimum of 12 statistical soil samples will be collected from locations identified using a systematic sampling grid with a random start.

Verification samples will be analyzed for the site COCs by SFL facilities in accordance with the applicable methods identified in Table 2-1. Contaminants of concern were selected in the 300 Area ROD (EPA 2013) based upon the 300 Area Remedial Investigation/Feasibility Study (DOE/RL-2010-99), which included a risk assessment. In the event that contaminants are discovered during remediation for which cleanup levels were not established in the ROD, the information will be presented to the DOE and EPA project managers for determination of a path forward. Results from the verification samples will be used in statistical and compliance calculations and site-specific modeling to demonstrate that cleanup objectives have been accomplished based on the anticipated land-use scenario for the site (i.e., industrial or unrestricted).

3.2.2.3 Vadose Zone Profile. Site closeout may include the use of analogous site information or sample collection from a test pit that is excavated in the lower vadose zone to establish a site-specific residual soil profile. The proposed scope for establishing the vadose zone profile (e.g., use of analogous site data or test pit excavation, test pit location, and sample constituents) will be identified by the project and implemented with concurrence from DOE and EPA. Where a test pit is used to establish the profile, samples should be collected at 1-m (3.3-ft) intervals and analyzed by SFL facilities in accordance with the applicable methods identified in Table 2-1. Results from test pit samples may be used in site-specific modeling to verify that cleanup objectives have been accomplished based on the anticipated land-use scenario for the site (i.e., industrial or unrestricted).

3.2.2.4 Field Quality Control Sampling. Field QC samples are collected and analyzed to provide an indication of sampling and analytical precision, contaminants that may be introduced through the use of nondisposable sampling equipment, and interlaboratory comparability. The application and frequency requirements for each field QC type that will be used during closeout of the 300 Area waste sites are presented in Table 3-3.

3.3 SAMPLE DESIGNATION

A unique number will be assigned for each sample using a sample tracking database.

Table 3-3. Field Quality Control Sampling Requirements Summary.

Quality Control Sample Type	Application	Frequency
Trip blanks	Volatile organic sampling only	--
Equipment rinsates (blanks)	Events using pre-cleaned, nondisposable sampling equipment[a]	One sample per waste site or closeout grouping, as appropriate.[a]
Field duplicates	All sampling	5% of all samples for a waste site or waste site group
Field splits	All sampling	5% of all samples for a waste site or waste site group

[a] When disposable tools (e.g., plastic sampling scoops and plastic bags) are used for sample collection, no equipment blank is required.

3.4 SAMPLING METHODS

All sampling will follow the SOPs listed in Appendix A. Sampling methods for waste characterization sampling are provided in Table 3-1. Sampling methods for closeout are site-specific and will be documented in site-specific work instructions. All verification samples for tritium will be taken 15 cm (6 in.) below the excavation surface. If tritium is detected, a path forward will be developed with the lead regulatory agency for appropriate cleanup verification sampling.

3.5 SAMPLE MANAGEMENT

3.5.1.1 Sample Custody. All samples obtained for this project shall be controlled from the point of origin to the analytical laboratory, as required by the HASQARD (DOE/RL-96-68), the S&C QAPP, and the SOPs provided in Appendix A. Sample custody during laboratory analysis will be addressed in the applicable laboratory SOPs. Laboratory custody procedures will ensure the maintenance of sample integrity and identification throughout the analytical process.

3.5.1.2 Sample Preservation, Containers, and Holding Times. Sample preservation, containers, and applicable holding times will be addressed for each analysis on sample authorization forms, shall comply with regulatory requirements, and meet the requirements of the HASQARD (DOE/RL-96-68), the S&C QAPP, and the SOPs provided in Appendix A. If holding times cannot be met, the reason for exceedance shall be documented in the field logbook or in the data package from the laboratory.

3.5.1.3 Sample Packaging and Shipping. Sample packaging and shipping will be performed by trained personnel in accordance with regulatory requirements and meet the requirements of the HASQARD (DOE/RL-96-68), the S&C QAPP, and the SOPs provided in Appendix A. Most samples submitted for SFL analysis will be screened for radioactivity prior to shipment offsite. On a case-by-case basis, the requirement for a radioactivity screen may be waived when sufficient data and/or historical information are available to authorize offsite shipment.

3.5.1.4 Field Documentation. Field documentation shall be kept in accordance with the requirements of the HASQARD (DOE/RL-96-68), the S&C QAPP for logbooks and forms, and the SOPs provided in Appendix A.

3.5.1.5 Sample Waste Management. Waste generated during sample collection will consist primarily of disposable items such as scoops, gloves, poly bags and sleeving, wipes or towels, and personal protective equipment. Analytical data and radiological controls screening information obtained from the soil samples will be used to disposition any waste generated during sample collection activities. Unused samples and associated laboratory waste for the analysis will be dispositioned in accordance with the applicable laboratory purchase order. In most cases, unused samples and laboratory waste will be disposed of by the laboratory performing the analysis. Pursuant to 40 CFR 300.440(a)(5), DOE approval is required before returning unused samples or waste from offsite laboratories. Approval of this SAP constitutes DOE approval for shipment of offsite and onsite laboratory sample waste back to the waste site or origin.

4.0 REFERENCES

40 CFR 61, "National Emission Standards for Hazardous Air Pollutants," *Code of Federal Regulations*, as amended.

40 CFR 261, "Identification and Listing of Hazardous Waste," *Code of Federal Regulations*, as amended.

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APPENDIX A

ANALYTICAL STANDARD OPERATING PROCEDURES

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ANALYTICAL STANDARD OPERATING PROCEDURES

The procedures listed below represent the current versions as of the approval date of this sampling and analysis plan (SAP). The most current effective version shall be used for all listed procedures for activities performed under this SAP.

SAMPLING PROCEDURES

WCH-314	*Sampling and Characterization Quality Assurance Program Plan, Volume 1: Administrative Requirements; Volume 2, Sampling Technical Requirements, Volume 3, Field Analytical Technical Requirements*
ENV-1-2.5	"Field Logbooks"
ENV-1-2.10	"Sample Event Coordination"
ENV-1-2.11	"Sample Documentation Processing"
ENV-1-2.12	"Data Package Validation"
ENV-1-2.13	"Chain of Custody"
ENV-1-2.14	"Sample Packaging and Shipping"
ENV-1-2.15	"Field Decontamination of Sampling Equipment"
ENV-1-2.16	"Soil and Sediment Sampling"
ENV-1-2.19	"Environmental Multi-Media Sampling"
ENV-1-2.20	"Sample Compositing"
ENV-1-2.37	"Sample Storage and Shipping Facility"

FIELD ANALYTICAL PROCEDURES

WCH-314	*Sampling and Characterization Quality Assurance Program Plan, Volume 1: Administrative Requirements; Volume 2, Sampling Technical Requirements, Volume 3, Field Analytical Technical Requirements*
ENV-1-2.5	"Field Logbooks"
ENV-1-2.13	"Chain of Custody"
ENV-1-2.24	"Routine Field Screening"
ENV-1-2.25	"pH Screening in Soil and Waste"
ENV-1-2.28	"Operation of WCH Field Portable X-Ray Fluorescence (XRF) Spectrometers"
ENV-1-2.34	"Documenting Environmental Radiological Surveys"
ENV-1-2.35	"Performance of Environmental Radiological Measurements"
ENV-1-2.39	"Portable Environmental Survey Radiological Instrument Performance Checks"
RC-300-4.1	"Radiological Counting Facility Quality Assurance"
RC-300-4.3	"In-Situ Object Counting System (ISOCS) Quality Assurance"

FIELD ANALYTICAL PROCEDURES

RC-300-5.1	"Radiological Counting Facility Sample Management and Waste Disposal"
RC-300-5.2	"Radiological Counting Facility Sample Preparation"

QUICK-TURNAROUND LABORATORY

Test America [a]	Corporate Analytical Procedures and Quality Assurance Plan
Eberline Services/GEL	Corporate Analytical Procedures and Quality Assurance Plan

STANDARD FIXED LABORATORY

Eberline Services/GEL	Corporate Analytical Procedures and Quality Assurance Plan
Test America [a]	Corporate Analytical Procedures and Quality Assurance Plan

[a] The Test America Laboratory was formerly Severn Trent Laboratory.

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